

### 3.3.3 Flooding

**Floods** are the result of a multitude of naturally-occurring and human-induced factors, but they all can be defined as the accumulation of too much water in too little time in a specific area. Types of floods that affect Montana include regional floods, flash floods, ice-jam floods, and dam-failure floods.

**Floodplains** are lands bordering rivers and streams that normally are dry but are covered with water during floods.

#### 3.3.3.1 Background

- Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth and water-resistance of the surface due to urbanization.
- During the 20th century, floods were the number-one natural disaster in the United States in terms of the number of lives lost and property damage.
- Buildings or other structures placed in floodplains can be damaged by floods.
- Buildings and fill material can change the pattern of water flow and increase flooding and flood damage on adjacent property by blocking the flow of water and increasing the width, depth, or velocity of flood waters.
- Most homeowner insurance policies do not cover flood damage. Individuals and business owners can protect themselves from financial losses by purchasing flood insurance through FEMA's National Flood Insurance Program.

Sources: FEMA, 2003; USGS, 2000; NOAA, 2004

##### 3.3.3.1.1 Regional and Flash Floods

**Riverine floods** result from precipitation over large areas and/or from snowmelt. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include many independent river basins. The duration of riverine floods may vary from a few hours to many days.

**Flash floods** are local floods of great volume and short duration. In contrast to riverine flooding, this type of flood usually results from a torrential rain on a relatively small drainage area. The flood wave from flash floods can move downstream too fast to allow escape, resulting in many deaths. Most flood-related deaths are due to flash floods. Fifty percent of all flash flood fatalities are vehicle related. Two feet of water is all that is necessary to carry most vehicles downstream during a flood.

Flash floods can occur within several seconds to several hours, with little warning. They can be deadly because they produce rapid rises in water levels and have devastating flow velocities.

Factors contributing to flash flooding include: rainfall intensity, rainfall duration, surface conditions, and topography and slope of the receiving basin. Urban areas are susceptible to flash floods because a high percentage of the surface area is composed of impervious streets, roofs, and parking lots where runoff occurs very rapidly. Mountainous areas also are susceptible to flash floods, as steep topography may funnel runoff into a narrow canyon. (USGS, 2000; NOAA, 2004)

Of specific concern for many Montana areas are flash floods as a result of rain falling in wildfire burn areas. This type of flash flood can occur rapidly with less amounts of rainfall than is normally needed for flash flooding. Areas downslope of recently-burned areas are at an increased risk for flash flooding and associated mudslides or debris flows.

#### **3.3.3.1.2 Ice Jam Floods**

An *ice jam* is an accumulation of ice in a river that restricts water flow and may cause backwater that floods low-lying areas upstream from the jam. Downstream areas also can be flooded if the jam releases suddenly, sending a flash flood downstream.

Damages resulting from ice jams can affect roads, bridges, buildings, and homes, and can cost the affected community thousands to millions of dollars. In most instances, ice jams result in highly localized, yet serious damages, which makes it difficult to obtain the type of disaster assistance available for large-scale flooding events.

#### **3.3.3.1.3 Dam Failure Floods**

*Dam failure floods* are usually associated with intense rainfall or prolonged flood conditions, but can occur during an earthquake. Dam failure may be caused by faulty design, construction and operational inadequacies, intentional breaches, or a flood event larger than the design flood.

The greatest threat from dam failure is to people and property in areas immediately below the dam since flood discharges decrease as the flood wave moves downstream.

The degree and extent of damage depend on the size of the dam and the circumstances of failure. A small dam retaining water in a stock pond may break resulting in little more damage than the loss of the structure itself. In contrast, a similar dam break could result in the loss of irrigation water for a season, causing extreme financial hardship to many farmers. An even larger dam failure might bring about considerable loss of property, destruction of cropland, roads and utilities and even loss of life. Consequences of dam failure that are more far-reaching can include loss of income, disruption of services and environmental devastation (MDES, 1996).

#### **3.3.3.2 History of Flooding in Montana**

Flooding is a common occurrence in Montana. Spring run-off from winter snow annually threatens downstream communities. The following discussion summarizes historical flooding in each major Montana watershed.

##### **3.3.3.2.1 Columbia River Basin Flooding**

The Columbia River Basin has been subject to numerous significant flooding events over the years. Some of these events are described below:

- The June 1908 flood in Missoula County involved nearly every major stream and river. This event was the result of unseasonably warm temperatures and thirty-three (33) consecutive days of rain.
- In June 1964, approximately fifteen (15) inches of rain accumulated over a (30) thirty-hour period in the upper Flathead drainage. The resulting flood damaged more than 350 houses near Kalispell. The Army Corps of Engineers estimated that the damages in the Flathead Basin totaled \$25 million.

- In January 1974, the counties of Lincoln, Sanders, Flathead, Glacier, Mineral, Missoula and Deer Lodge were hit by flood waters which caused approximately \$16 million worth of damage to Forest Service roads, bridges, and facilities, and private property. These same counties suffered flood related losses again in June 1975, totaling nearly \$35 million (MDES, 1996)

### **3.3.3.2.2 Missouri River Basin Flooding**

The most damaging flood in the Missouri River Basin occurred in June 1964. The principal rivers involved were the Dearborn, Sun, Teton and Marias. The event was initiated by eight to ten inches of rain over three days on a deeper-than-average snow pack. All counties situated along the Continental Divide were affected to some degree. However, the greatest damage was received by the City of Great Falls. This disaster resulted in the loss of 30 lives and an estimated \$55 million in damages, with the greatest damage in the city of Great Falls. The US Army Corps of Engineers has since completed a \$12 million flood control levee along the north bank of the Sun River near Great Falls, which protects over 500 homes and businesses.

In 1984, the combination of snowmelt and spring rains with frequent ice jams caused flooding on the Beaverhead River near Dillon. Crews successfully prevented major damage by channeling floodwaters through town on streets lined with sandbags and straw. The Clark Canyon Dam above Dillon and emergency dikes built on the river near town reduced potential damages.

Significant floods have occurred on the Milk River and its tributaries primarily as a result of rapid snowmelt over frozen soil. Heavy snow, the associated snowmelt, and ice jams caused the greatest flood on record for this river in April 1952. Over \$6 million (1952 dollars) in damages were recorded between Havre and the river's mouth below Nashua, causing significant economic impacts during this month long flood. Over 1,000 homes flooded and almost 3,000 people evacuated. Levees offered limited protection to the communities of Havre, Chinook, Malta, Saco, Glasgow, and Nashua. In September 1986, another significant flood impacted those along the Milk River from Havre to Nashua causing over \$3 million (1986 dollars) in FEMA reimbursed damages and one death, but by some sources over \$36 million in total damages (MDES, 1996; USACE, 1953; NWS, 2000; Dartmouth, 2003).

### **3.3.3.2.3 Yellowstone River Basin Flooding**

The Yellowstone River system is one of the remaining large rivers in this country that does not have a major flood control dam, with the exception of the Yellowtail Dam on the Big Horn River. Large floods have affected the Glendive area near the end of the Yellowstone River, typically as a result of ice jams. Flooding in 1899 took twelve lives and destroyed a new bridge. In 1936, another ice jam isolated Glendive for 10 days. The Army Corps of Engineers built a levee in 1959, which protects a portion of the town, but does not provide adequate protection from even 50-year ice jam floods. Miles City, located at the junction of the Tongue and Yellowstone Rivers is one of the more flood prone towns in the state. Limited protection of the city is afforded by levees. Most recently, extensive flooding occurred in Park County near Livingston and Yellowstone County in 1996 and 1997 (MDES, 1996; NWS, 2001).

### 3.3.3.2.4 Flash Flooding in Montana

Flash flooding is common in some areas of the state during the summer storm season. The best examples of this type of flooding have occurred in the Billings area. Flooding of the tributaries of the Yellowstone River has resulted from intense summer thunderstorms, typically short in duration, which produce high peak flows. Major flooding of this type occurred in 1923 and 1937. Flash flooding is also common along drainages in Lincoln, Sanders, Flathead, Glacier, Mineral, Missoula and Deer Lodge Counties during the summer storm season. (MDES, 1996) Eastern Montana is also not immune to flash flooding. Heavy rainfall from thunderstorms can cause creeks and streams to rise rapidly. Tens of people were killed in Wibaux at the turn of the century when a train was swept off of its tracks, and portions of Montana Highway 2 are known to be prone to flash flooding.

### 3.3.3.2.5 Ice Jam Flooding in Montana

In Montana, 1,473 ice jam events have been recorded, the most of any lower 48 state. These ice jam events have been reported on 163 different streams and rivers and 199 different locations. Twenty-one percent of the ice jams have occurred in February with 45 percent occurring in March (NWS, 2007). Recorded ice jams do not always indicate flooding occurred with the ice jam, just the presence of an ice jam and the increased risk of flooding.

The majority of ice jams occur east of the Continental Divide with the most events occurring in Miles City on the Yellowstone River (44), Bozeman on Hyalite and Bridger Creeks (40), and in the towns of Nashua (36), Sidney (34), Zortman, Wolf Point, and Harlowton with 25 or more recorded events (**Figure 3.3.3-1**). West of the Continental Divide, ice jams occur most frequently on the Clark Fork River with 27 events and in the town of Libby with 13 events (**Figure 3.3.3-2**). The most ice jams reported for one river have occurred on the Missouri River, with 157 events, followed by the Yellowstone with 106, and the Milk River with 103 events. Note that this database is dependent on reported ice jams, and in many instances, particularly in rural areas, many ice jams may go unreported. **Table 3.3.3-1** summarizes some of the damages caused by ice jams.

**Table 3.3.3-1 Ice Jams in Montana**

For Montana residents living near rivers, ice jams can cause loss of life, damage to property, roads and structures, and disruption of lives. Examples of some of the damages caused by ice jams are listed below.

**Loss of Life:**

- 1894: Three men died while trying to escape ice jam flood waters in the Glendive area.
- 1899: Twelve people lost their lives to an ice-jam and flash flood in the Glendive area on the Yellowstone River.
- 1996: A volunteer in Fort Benton collapsed and died from a heart attack as he was helping to load sandbags.
- 1996: Two died because of ice jam flooding.

**Property Damage:**

- 1881: Main Street in Miles City filled with water from an ice jam in March. Residents evacuated to higher ground for one week, which they spent in tents, waiting for the floodwaters to recede.
- 1944: An ice jam on the Tongue and Yellowstone Rivers in Miles City caused 300 to 500 people to be evacuated from their homes.

**Agricultural Damage:**

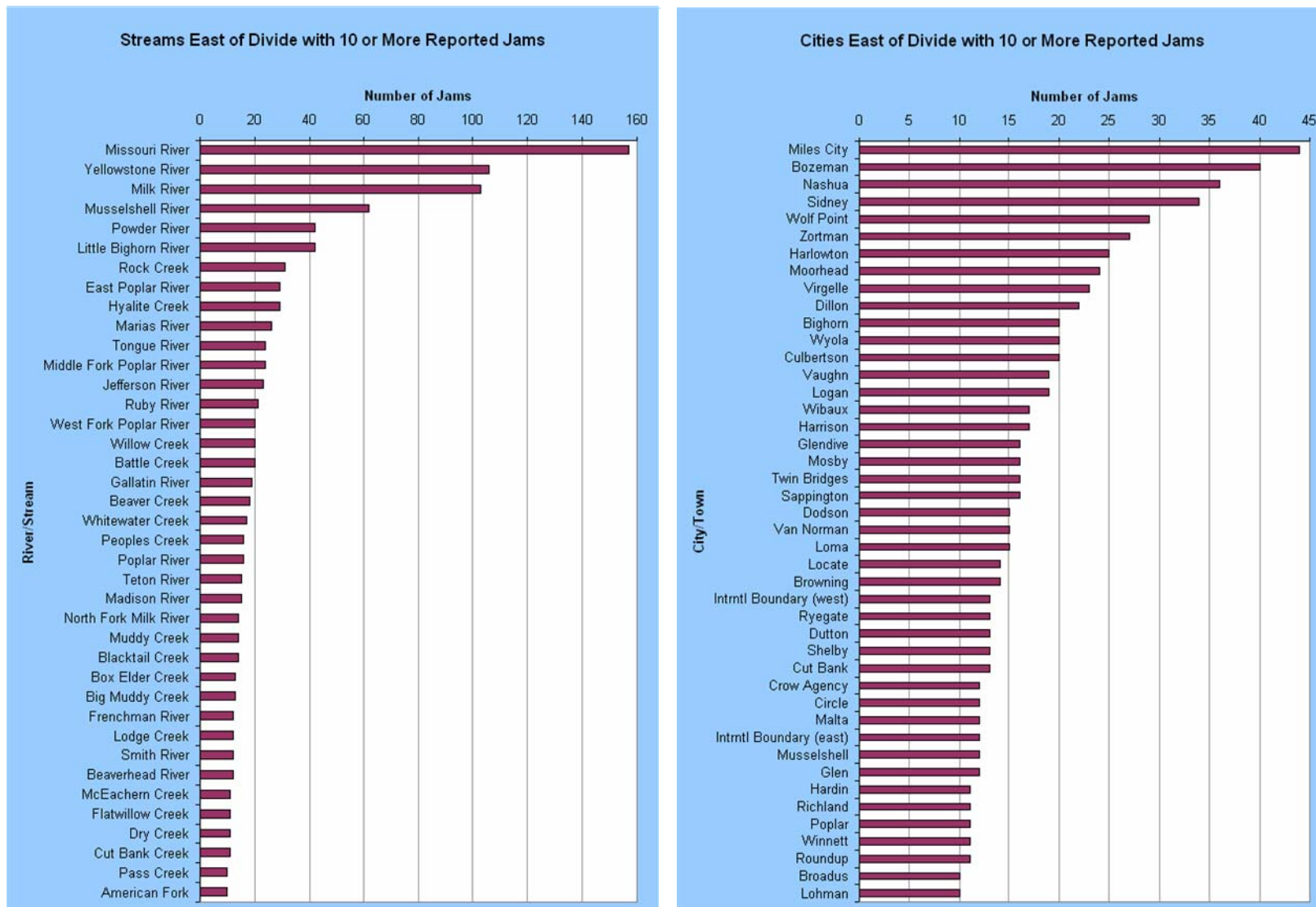
- 1972: Yellowstone River ice jam in Richland County inundated 2500 acres of farmland, resulting in loss of fertilizer and damage to fill ditches.
- 1994: Rosebud County ice jam caused a flash flood that killed 60 cattle, a loss of \$60,000.

**Environmental Damage:**

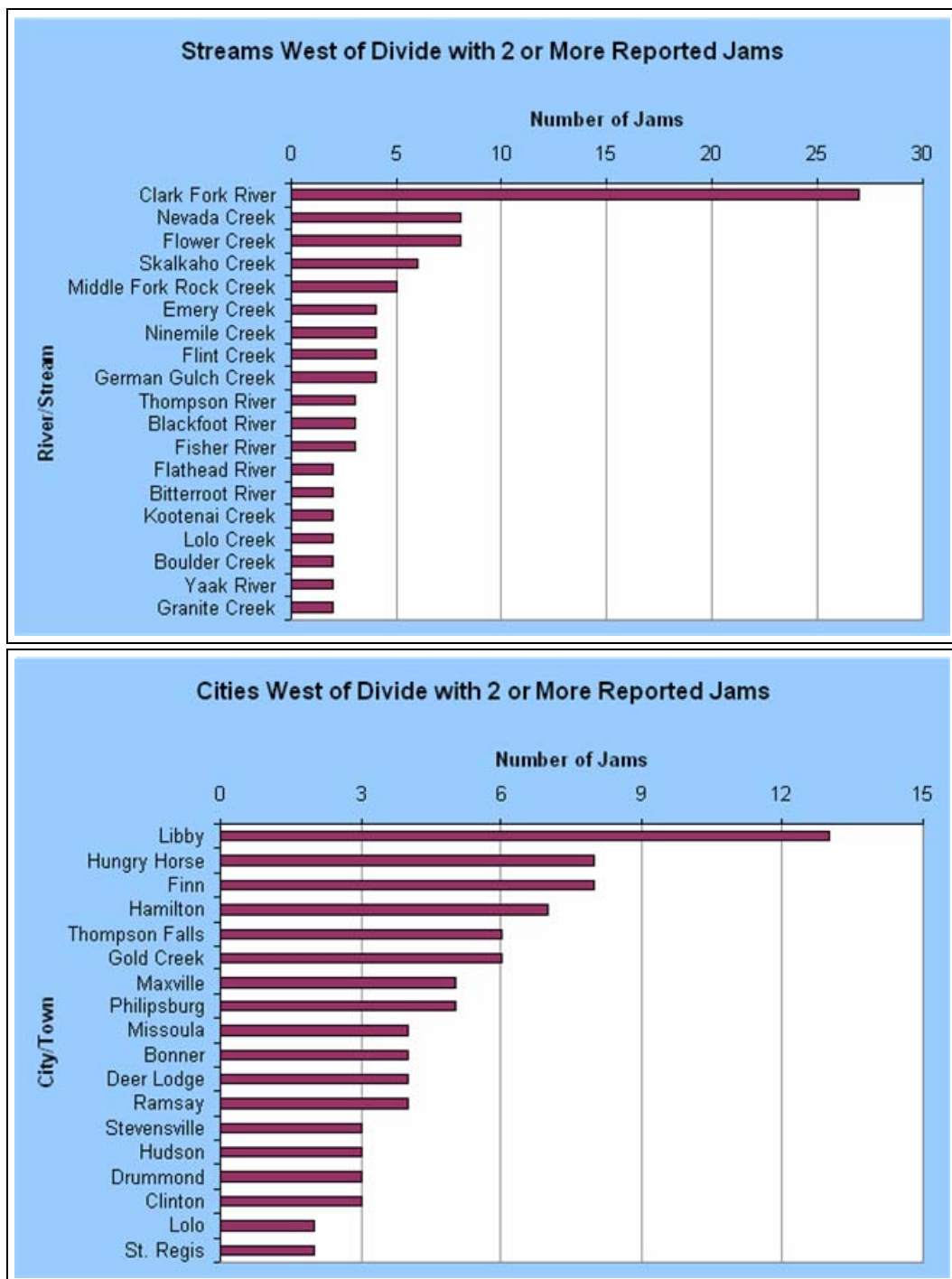
- 1996: Fish killed in the Blackfoot River by habitat destruction and disruption of spawning activity.
- 1996: Fish killed in Clark Fork River by ice jam scouring and releases of soils contaminated with metals toxic to fish.

Source: USACE CRREL, 1998

**Figure 3.3.3-1 Montana Cities and Streams East of the Continental Divide with the Most Reported Ice Jams**  
Source: National Weather Service, 2007

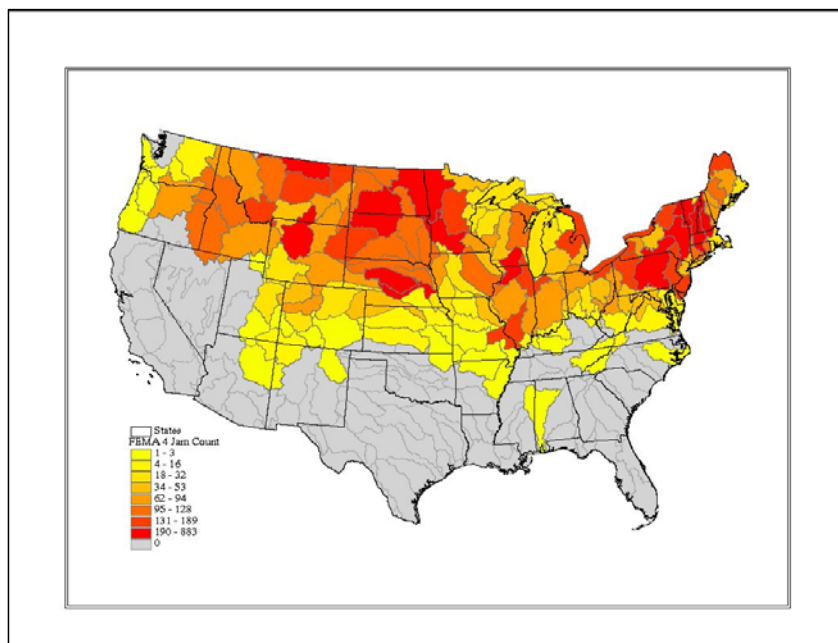


**Figure 3.3.3-2 Montana Cities and Streams West of the Continental Divide with the Most Reported Ice Jams**  
Source: National Weather Service, 2007





**Figure 3.3.3-3 Number of Ice Jams in the U.S. Shown by Hydrologic Unit**  
Source: USACE CRREL, 2007



Approximately 11 percent of the reported ice jams in Montana have known damages. The most common damages include bridge and residential damage, road flooding, evacuations, dike and levee damage, and agricultural damage. There have been at least 17 deaths from ice jam flooding in Montana. The majority of these deaths were due to flash floods released during ice jam break-up (USACE CRREL, 1998 and 2004).

#### 3.3.3.2.6 Dam Failure Floods in Montana

Dam failure floods in Montana have primarily been associated with riverine and flash flooding. Nevertheless, the potential for a major flood occurring solely as a result of dam failure is a real possibility. Dam-failure related flooding in Montana is summarized in **Table 3.3.3-2**. As shown in the table, there have been 34 deaths and extensive property damage from dam-failure flooding in Montana.

**Table 3.3.3-2 Montana Dam Failures and Incidents**

Date	Event	Damages
June 4, 1908	<b>White's Reservoir Dam near Butte</b> failed leaving the city without phones, telegraphs, electricity, street cars, or railroad service.	
July 11, 1916	<b>Superior Dam</b> , north of Meaderville, broke and flooded <b>northeast Butte</b> with mine tailings.	\$8,000
1927	<b>Pattengail Creek Dam in Beaverhead County</b> failed causing four known deaths and near complete destruction of the towns of Dewey and Wise River.	4 deaths
March 1939	<b>Midway Dam</b> , 40 miles northwest of Nashua, breached during the Porcupine Creek flood when the spillway was undermined by huge floating ice cakes. When the dam failed, a four-foot liquid wall swept down the valley causing extensive damage.	

**Table 3.3.3-2 Montana Dam Failures and Incidents**

Date	Event	Damages
July 1946	<b>Carrol Dam</b> , located eight miles northwest of <b>Plentywood</b> , failed following several inches of rain in a short timeframe. There were no fatalities attributable to the dam failure but destruction was evident throughout the 15 mile valley which took the brunt of the flood. Several homes and farm buildings were destroyed.	
April 1952	<b>Frenchman Dam</b> on Frenchman Creek failed upstream of the Milk River. The dam was located in Phillips County, 20 miles north of Saco. The dam failure caused the highest peak ever recorded on the Milk River below its confluence with Frenchman Creek.	\$150,000
1964	Failure of <b>Swift Reservoir on Birch Creek and Two Medicine Dam on Two Medicine Creek</b> resulted in the loss of 30 lives on the Blackfeet Indian Reservation.	30 deaths
June 20, 1984	<b>Browns Lake Dam</b> , located in <b>Beaverhead County</b> , was overtopped resulting in washed out roads and bridges downstream.	Property damage: \$100,000
July 11, 1996	Incident Response in <b>Granite County</b> (EO 16-96) for the possible failure of the <b>East Fork of Rock Creek Dam</b> .	
June 1, 1998	Incident Response for <b>Tin Cup Dam</b> (EO 9-98). State response to a leak in Tin Cup Dam, located in the <b>Selway-Bitterroot Wilderness Area</b> of the Bitterroot National Forest, Ravalli County.	
Spring 1998	<b>Anita Dam</b> outlet failure – BLM dam – north of Chinook. Evacuation necessary.	
Summer 2002	Failure of <b>Ross Dam</b> in Garfield County; evacuation necessary but limited damage downstream.	

Source: MDES, 1998 and 2003; Maxim, 2003a, 2003b; BSHM 2004

### 3.3.3.3 Declared Disasters from Flooding

Montana counties with emergency and disaster declarations for floods since 1974 are shown in **Table 3.3.3-3**. There has been \$24 million in Federal and over \$5.5 million in State assistance for damages to public structures and infrastructure in the past 33 years, or about \$1 million per year.

**Table 3.3.3-3 State and Federal Declarations for Flooding in Montana (1974 through 2006)**

Year	State and Federal Declarations (number)	Public Assistance			Individual Assistance		Total
		Federal	State	Local	Federal	State	
1974	FDAA-417-DR-MT	\$603,144					\$603,144
1975	FDAA-472-DR-MT and IFG-267 Grants	\$2,070,551			\$385,023	\$128,341	\$2,583,915
1976	Town of Froid		\$31,268	\$718			\$31,986
1978	FDAA-558-DR-MT and IFG-226 Grants	\$3,838,126	\$140,876	\$25,874	\$465,015	\$155,005	\$4,624,896
1979	Fergus & Petroleum Counties		\$97,048	\$885			\$97,933
1981	FEMA-640-DR-MT; FG-486 Grants	\$4,733,120	\$944,132	\$313,286			\$5,990,538
1984	Beaverhead and Madison County		\$607,600	\$51,559			\$659,159
1986	FEMA-761/777-DR-MT; IFG-106 Grants	\$2,390,854	\$212,442	\$584,501	\$127,209	\$42,403	\$3,357,409
1991	EO 12-91; EO 14-91; EO 15-91; EO 24-91		\$570,459	\$94,849			\$665,308
1993	EO 11-93		\$105,630	\$15,910			\$121,540
1994	EO 04-94; EO 05-94		\$64,156	\$4,339			\$68,495



**Table 3.3.3-3 State and Federal Declarations for Flooding in Montana (1974 through 2006)**

Year	State and Federal Declarations (number)	Public Assistance			Individual Assistance		Total
		Federal	State	Local	Federal	State	
1995	EO 1-95; EO 15-95		\$38,994	\$385			\$39,379
1996	EO 12-96		\$196,876	\$128,484			\$325,360
1996	EO 3-96; FEMA 1105-DR-MT	\$1,820,739	\$241,888	\$365,006			\$2,427,633
1996	EO 7-96; FEMA 1113-DR-MT	\$1,480,471	\$179,892	\$313,594			\$1,973,957
1997	EO 4-97; 5-97; 6-97; 7-97; 12-97; FEMA-1183-DR-MT	\$5,762,964	\$583,222	\$1,413,362			\$7,759,548
1997	Ice Jams (EO 2-97)		\$1,988				\$1,988
1999	EO 3-99		\$546,305	\$10,062			\$556,367
2001	EO 19-01		\$56,322	\$15,424			\$71,746
2002	EO 13-02 FEMA 1424-DR-MT	\$1,424,941	\$35,783	\$439,197			\$1,899,921
2003	EO 4-03; 5-03		\$14,260	\$92,898			\$107,158
2005	EO 09-05; 11-2005 15-2005	\$788,055	\$98,220			\$886,275	\$788,055
2006	EO 39-06		\$112,000	\$143,374			\$255,374
<b>TOTAL</b>		<b>\$24,124,910</b>	<b>\$5,569,196</b>	<b>\$4,111,927</b>	<b>\$977,247</b>	<b>\$325,749</b>	<b>\$35,109,029</b>

Source: MDES, 2007

Damages by types of floods from 1997 to 2006 are listed in **Table 3.3.3-4**.

**Table 3.3.3-4 Ten-Year NOAA Montana Flood Summary (1997 through 2006)**

Location or County	Death	Injuries	Property Damage	Crop Damage	Total
Flash Floods	0	0	\$9,191,000	\$675,000	<b>\$9,866,000</b>
Regional Floods	0	0	\$4,496,000	0	<b>\$4,496,000</b>
Urban/Small Streams	0	0	\$75,000	0	<b>\$75,000</b>
<b>TOTAL</b>	<b>0</b>	<b>0</b>	<b>\$13,762,000</b>	<b>\$675,000</b>	<b>\$4,571,000</b>

Source: NOAA-NCDC, 2007

### 3.3.3.4 Vulnerability to Flooding

Flooding becomes a hazard when people compete with nature for the use of floodplains. If floodplain areas were left in their natural state, flooding would not cause major damage. Urban, industrial and other surface development in natural floodplain areas of Montana has increased the vulnerability to serious flooding. The extent of artificial surface area created by development prevents rainfall from soaking into the ground and increases the rate of runoff.

#### 3.3.3.4.1 Statewide Vulnerability to Flooding

##### ***Riverine and Flash Flooding***

Vulnerability to flooding is dependent on local weather conditions, local development patterns and site specific flood water constraints. Some areas can be completely immune to flooding because the steep incised river banks have physically impeded development near the river, limiting flood damage when floodwaters arrive. Other areas experience flooding

annually where meandering rivers have created broad floodplains and development has encroached and impeded floodwaters. Because local conditions have a significant impact on the vulnerability to flooding, historic data on occurrence and loss is the best means to assess flooding vulnerability statewide.

The historic flooding damage indirectly identifies the vulnerability to flooding. The National Flood Insurance Program (NFIP) is the primary insurer for flood insurance in the U.S. The NFIP paid over \$5.3 million in claims from the flooding of insured properties from 1978 through 2006 in Montana (NFIP, 2007). The five counties and five cities with the highest flood insurance claims are shown below in **Table 3.3.3-5**. Note that although flood insurance claims are being used to show past losses, this data is not an entirely accurate representation of flood losses. Many homeowners without flood insurance may have sustained flood damages and those losses would not be reflected in these figures.

**Figure 3.3.3-4** is intended to show the relative exposure to flooding in counties across the state. It displays the relative aggregate amount of insured property for flood damage within a county. For each county, the total flood damage claims in dollars for insured properties from January 1978 through January 2007 is shown. Communities with flood hazard areas that are not participating in the NFIP are also identified. **Table 3.3.3-5** shows the communities with the most flood insurance claims by dollar amounts.

**Table 3.3.3-5 Communities With Highest Flood Insurance Claims (January 1978 to January 2007)**

Counties	Insurance Claim Amount	Cities	Insurance Claim Amount
Park	\$659,965	Miles City	\$261,723
Valley	\$431,038	Roundup	\$212,754
Sweet Grass	\$378,110	Billings	\$190,055
Missoula	\$326,891	Columbia Falls	\$110,829
Yellowstone	\$301,913	Bozeman	\$110,466

Source: NFIP, 2007

Montana has 43 known Repetitive Loss (RL) Properties as listed in **Table 3.3.3-6**. There are currently no known Severe Repetitive Loss (SRL) properties in the state of Montana. Both the State Hazard Mitigation Officer and the State Floodplain Administrator are committed to encourage the jurisdictions that contain these structures to pursue mitigation actions with the respective private owners through various FEMA funding streams, either through PDM, FMA, RL, HMGP and SRL if any properties are so designated in the future.

**Table 3.3.3-6 Top 50 Communities with Highest Number of Repetitive Loss Properties as of April 30, 2007**

Community	Community Number	Number of Repetitive Loss Properties	% of Total Found in this Community
Valley County*	300171	14	32.56%
Park County	300160	7	16.28%
Cascade County	300008	3	6.98%
Billings, City of	300085	2	4.65%
Lincoln County*	300157	2	4.65%
Meagher County*	300046	2	4.65%
Missoula County*	300048	2	4.65%
Yellowstone County*	300142	2	4.65%
Carbon County*	300139	1	2.33%

**Table 3.3.3-6 Top 50 Communities with Highest Number of Repetitive Loss Properties as of April 30, 2007**

Community	Community Number	Number of Repetitive Loss Properties	% of Total Found in this Community
Glasgow, City of	300178	1	2.33%
Great Falls, City of	300010	1	2.33%
Lake County*	300155	1	2.33%
Lewis and Clark County*	300038	1	2.33%
Malta, City of	300054	1	2.33%
Missoula, City of	300049	1	2.33%
Phillips County*	300162	1	2.33%
Ravalli County*	300061	1	2.33%

The strategy is to work with local communities to review repetitive loss structures, utilize previous mitigation plans and develop project plans which would include multi-agency collaboration where possible. Valley and Park Counties together have had over 50% of the losses for the state. Floodplain mitigation planning work has already been completed in these communities. Valley County has in place a 2000 Flood Hazard Mitigation Plan and a 2003 Pre-Disaster Mitigation Plan including projects that would reduce flooding hazards. Guidance for general floodplain mitigation is included in the Park County Flood Hazard Mitigation Plan dated 1998 while newer information is included their 2006 Pre-Disaster Mitigation Plan. In addition to Valley and Park Counties 15 other jurisdictions have incurred repetitive losses. One to three structure losses have occurred in these communities and hence would be a lower three year priority than efforts planned for Valley and Park Counties, but all of these 15 jurisdictions will also be encouraged by the State of Montana to consider and pursue mitigation actions for these properties as well.

### ***Ice Jam Flooding***

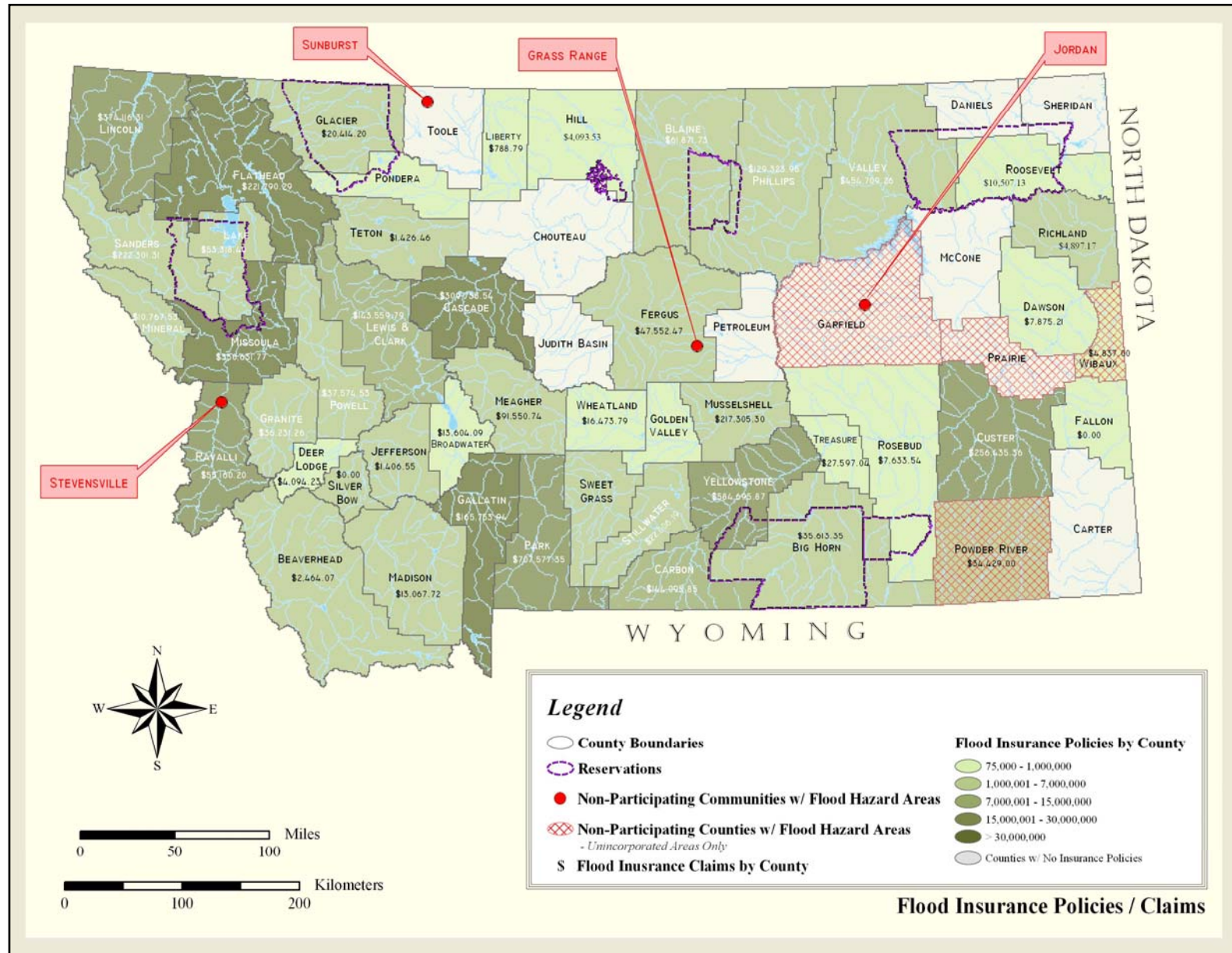
Ice jam flooding is more likely to occur in break-up events as opposed to freeze-up events. Sudden seasonal changes are the greatest factor increasing the risk of ice jam flooding. Prolonged cold periods causing significant ice formation followed by unseasonably warm periods in the winter or spring are likely formulas for ice jams. The best means to determine vulnerability is to evaluate patterns and frequency of previous ice jam flooding. Ice jam events recorded the by U.S. Army Corps of Engineers (USACE CRREL, 2007) have been plotted to show spatial occurrence (**Figure 3.3.3-5**). Areas that experienced ice jam events in the past are the most likely to experience future flooding related to ice jams.

### ***Dam Failure Flooding***

Vulnerability to dam failure flooding is compounded by differences in the dam inundation areas versus the 100-year floodplain. Floodplain development, in most cases, is regulated, whereas dam inundation areas are not. Extreme rain and snow melt events can exceed the flood storage capacity of even large reservoirs. At such times, the excess water that passes over the spillway (the primary purpose of which is to protect the dam) may cause damages downstream that approach those damages that would have occurred had the flood control dam not been built. In addition, the failure of a dam can produce extreme, rapid flood damages outside the 100-year or even 500-year floodplains (MDES, 1996). High hazard dams and population density are shown on **Figure 3.3.3-6**.

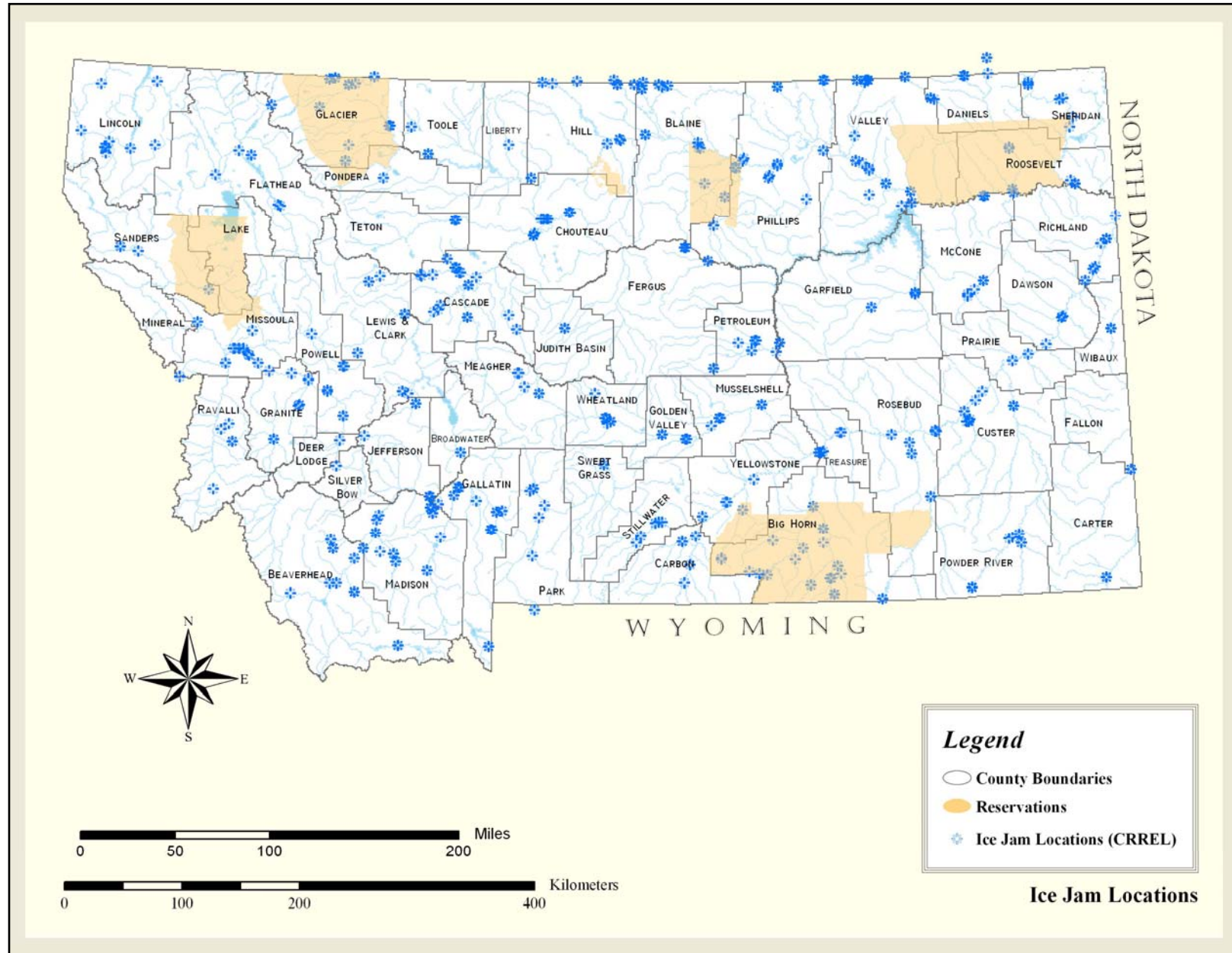
Montana has approximately 3,544 dams (DNRC, 2007). Of these dams, 182 are considered "high-hazard dams", indicating they are upstream from populated areas (**Figure 3.3.3-5**). **Table 3.3.3-7** summarizes the hazard categories of dams by type of ownership.

**Figure 3.3.3-4 Insurance Amounts through the National Flood Insurance Program and Claim Information from January 1978 through December 2003.**

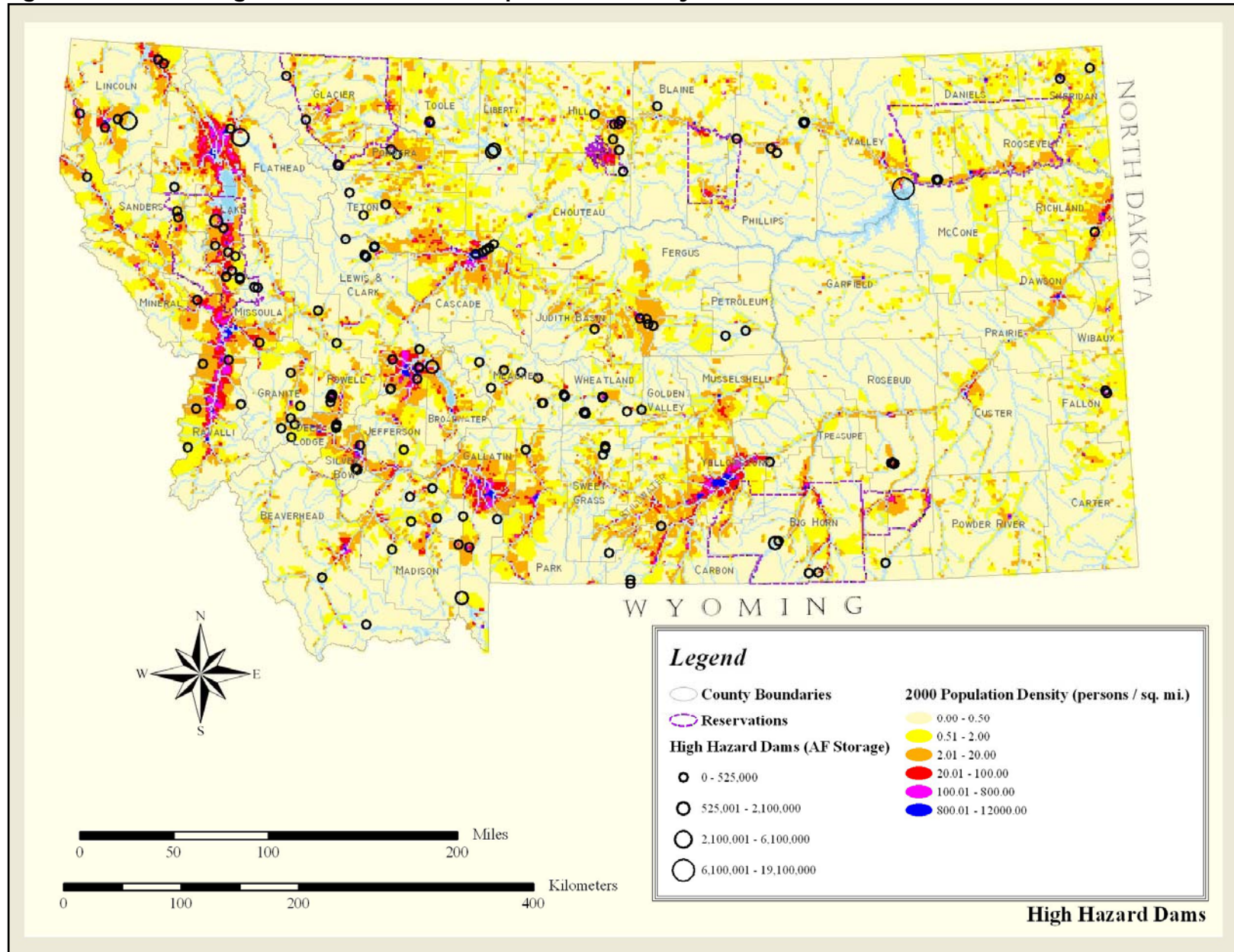




**Figure 3.3.3-5 Ice Jam Locations**



**Figure 3.3.3-6 High Hazard Dams and Population Density**





**Table 3.3.3-7 Number of Dams within the State of Montana**

Hazard Categories	Federal Dams	State Dams	Local Government Dams	Public Utility Dams	Private Dams	Total
High	44	33	37	19	49	182
Significant	24	2	3	3	137	169
Low	480	135	38	3	2,537	3,193
<b>TOTAL</b>	<b>548</b>	<b>170</b>	<b>78</b>	<b>25</b>	<b>2,723</b>	<b>3,544</b>

Source: Montana DNRC, 2007

**Dams with Deficiencies or Requiring Further Analysis**

In 1981, the United States Army Corps of Engineers (USACE) completed inspection of non-Federal dams in Montana. Generally, the USACE inspected dams that were at least 25 feet high or impounded at least 50 acre-feet of water and were located upstream from populated areas or areas where dam failure could cause serious property damage. Deficiencies were found in 32 of the dams inspected by the USACE (MDES, 1996). Since that time, the Montana DNRC has determined that 28 of the 32 dams meet State standards, either because of reduction in storage capacity, rehabilitation, or re-evaluation (Lemieux, 2007). **Table 3.3.3-8** shows the remaining dams on the 1981 USACE list, plus five other dams determined deficient by DNRC.

**Table 3.3.3-8 Non-Federal Dams in Montana Requiring Further Analysis or Rehabilitation**

Name	County	River	Nearest Community	Owner
East Fork Dam <sup>1</sup>	Fergus	East Fork Big Spring	Lewistown	City of Lewistown
Big Sky Dam <sup>2</sup>	Madison	Middle & West Forks, Gallatin River	Gallatin Gateway	Big Sky of Montana, Inc.
Ruby Dam <sup>3</sup>	Madison	Ruby River	Alder	MT DNRC
Yellow Water Main <sup>1</sup>	Petroleum	Yellow Water Creek	Mosby	MT DNRC
Upper Taylor Dam <sup>2</sup>	Powell	Upper Taylor Creek	Deer Lodge	MT Dept. of Corrections
Northern Pacific Reservoir Dam	Jefferson	McClellan Creek	East Helena	Asarco, Inc.
Lake Frances <sup>3</sup>	Pondera		Valier	Pondera Canal and Reservoir Company
Beaver Creek Dam <sup>3</sup>	Hill	Beaver Creek	Havre	Hill County
Ackley Lake Dam <sup>3</sup>	Judith Basin	Hauck Coulee	Hobson	MT DNRC

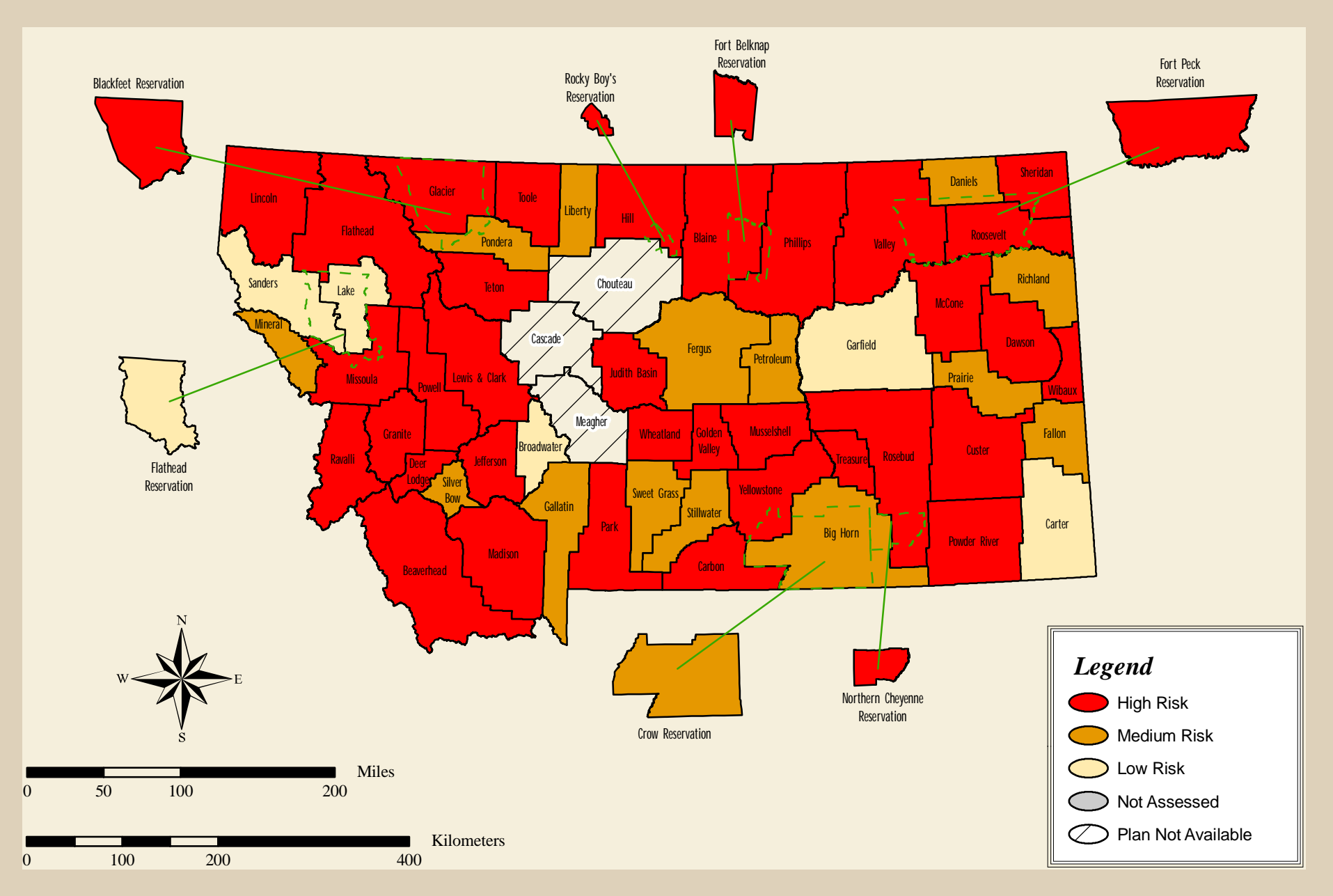
<sup>1</sup> Compliance with spillway standards has not yet been completed.<sup>2</sup> Analysis of spillway capacity is currently underway<sup>3</sup> Scheduled for rehabilitation in the next five years

Source: Lemieux, 2007

**3.3.3.4.2 Review of Potential Losses in Local PDM Plans**

**Figure 3.3.3-7** presents the Hazard Risk Map of flooding. The colors represent a high-medium-low risk rating based on information in the Local PDM Plans. The gray color indicates this hazard was not assessed in the Local Plan. The hatch pattern indicates the Local Plans were not available for review. For electronic users of the State Plan, clicking on a county or tribal reservation will take you to the Local Plan where further information is available.

Figure 3.3.3-7 Hazard Risk Map: Flood



**Table 3.3.3-9** presents a summary of potential loss estimates due to flooding as calculated in the Local PDM Plans. Some Local Plans calculated a separate loss figure for flooding associated with dam failure, ice jams, and riverine flooding, while other Local Plans presented one combined figure for all types of flooding. Flooding loss is described in terms of its effect on buildings, society and the economy, where generally:

- Building loss is presented either as a dollar value or a high-moderate-low rating and typically refers to the potential loss to critical facilities in the jurisdiction.
- Societal loss is presented either as the number of lives at risk or as a high-moderate-low rating representing the potential for loss of human life.
- Economic risk is presented as a dollar value or high-moderate-low rating referring to the potential impact to the economy of the local jurisdiction.

References cited in **Table 3.3.3-9** correspond to a description of the method used to calculate potential loss that can be found in *Section 7.14*.

**Table 3.3.3-9 Potential Losses from Local Plans: Flooding**

DES District	Type of Flooding	Jurisdiction	Building Loss	Societal Loss	Economic Loss	Reference
1	Dam Failure	Deer Lodge County	Moderate	Moderate	Moderate	1
1	Dam Failure	Flathead County	High	High	High	8
1	Dam Failure	Granite County	Moderate	Moderate	Moderate	1
1	Dam Failure	Lincoln County	3	2	NA	9
1	Dam Failure	Missoula County	\$5-\$10 million	Moderate	NA	10
1	Dam Failure	Ravalli County	\$500 million-\$1 billion	Very High	NA	10
1	Dam Failure	Silver Bow County	\$9 million	Moderate	Moderate	1
1	Ice Jam	Mineral County	\$500,000-\$1 million	Low	NA	10
1	Ice Jam	Missoula County	\$500,000-\$1 million	Low	NA	10
1	Ice Jam	Powell County	High	Low	NA	10
1	Ice Jam	Ravalli County	\$500,000-\$1 million	Low	NA	10
1	Riverine	Deer Lodge County	\$2,500,000	Moderate	High	1
1	Riverine	Flathead County	\$107,000,000	Moderate	Moderate	8
1	Riverine	Flathead Reservation	\$73,171,600	603	NA	2
1	Riverine	Granite County	\$11,500,000	Moderate	Moderate	1
1	Riverine	Lake County	\$73,171,600	603	NA	2
1	Riverine	Lincoln County	2	1	NA	9
1	Riverine	Mineral County	\$8-\$10 million	Moderate	NA	10
1	Riverine	Missoula County	\$30-\$40 million	Moderate	NA	10
1	Riverine	Powell County	High	Low-Medium	NA	10
1	Riverine	Ravalli County	\$5-\$10 million	High	NA	10
1	Riverine	Sanders County	\$7,438,289	1184	NA	2
1	Riverine	Silver Bow County	\$7 million	Moderate	Moderate	1
2	All Types	Blackfeet Reservation	\$13,248,620	326.9	NA	2
2	All Types	Blaine County	\$4,259,351	80.5	NA	2
2	All Types	Fort Belknap Reservation	\$721,429	9.8	NA	2
2	All Types	Rocky Boy's Reservation	\$5,921,240	0.5	NA	2
2	Riverine	Cascade County	U	U	U	
2	Riverine	Chouteau County	U	U	U	
2	Riverine	Glacier County	NA	NA	NA	

**Table 3.3.3-9 Potential Losses from Local Plans: Flooding**

DES District	Type of Flooding	Jurisdiction	Building Loss	Societal Loss	Economic Loss	Reference
2	Riverine	Hill County	\$15,808,021	339.5	NA	2
2	Riverine	Liberty County	Medium-High	Medium	NA	11
2	Riverine	Pondera County	NA	NA	NA	
2	Riverine	Teton County	NA	NA	NA	
2	Riverine	Toole County	Medium	Low	NA	11
3	Dam Failure	Broadwater County	\$30,000,000	Moderate	Moderate	1
3	Dam Failure	Park County	\$793,000	Moderate	Low	1
3	Ice Jam	Broadwater County	\$1,500,000	Moderate	Moderate	1
3	Riverine	Beaverhead County	\$15,100	389	NA	5
3	Riverine	Broadwater County	\$1,800,000	Moderate	Moderate	1
3	Riverine	Gallatin County	Moderate	Moderate	Moderate	12
3	Riverine	Jefferson County	NA	NA	NA	
3	Riverine	Lewis & Clark County	\$2,000,000	NA	NA	6
3	Riverine	Madison County	NA	NA	NA	
3	Riverine	Meagher County	U	U	U	
3	Riverine	Park County	\$18,900,000	Moderate	Moderate	1
3	Riverine	Sweet Grass County	NA	NA	NA	
4	Dam Failure	Carter County	Low	Low	Low	12
4	Dam Failure	Fallon County	\$48,000 per home	NA	\$877,193	8
4	Dam Failure	Richland County	\$150,000	NA	NA	3
4	Riverine	Carter County	Low	Low	Low	12
4	Riverine	Custer County	\$5.7 to \$43.2 million	Moderate	NA	13
4	Riverine	Dawson County	\$11,562,00	NA	NA	8
4	Riverine	Fallon County	\$111,421 to \$557,102	NA	NA	8
4	Riverine	Garfield County	\$1,480,000	Moderate	Moderate	1
4	Riverine	McCone County	\$238,706	NA	\$384,615	3
4	Riverine	Powder River County	\$8 million	Moderate	Moderate	1
4	Riverine	Prairie County	\$36.5K per home; \$90k per mile	NA	\$877,000	3
4	Riverine	Richland County	\$801,826	NA	\$384,615	3
4	Riverine	Wibaux County	\$1,259,125	Low	\$1,284,372	3
5	All Types	Golden Valley County	\$124,956	2.81	NA	2
5	All Types	Musselshell County	\$1,642,170	49.61	NA	2
5	All Types	Wheatland County	\$1,505,988	12	NA	2
5	Dam Failure	Big Horn County	High	High	High	3
5	Dam Failure	Crow Reservation	High	High	High	3
5	Dam Failure	Northern Cheyenne Reservation	Low	Low	Low	3
5	Dam Failure	Stillwater County	\$11,500,000	NA	NA	8
5	Riverine	Big Horn County	Millions	Moderate	\$23 million	3
5	Riverine	Carbon County	\$800,000	NA	NA	8
5	Riverine	Crow Reservation	Millions	High	Millions	3
5	Riverine	Northern Cheyenne Reservation	Millions	Moderate	Millions	3
5	Riverine	Rosebud County	High	Moderate	Moderate	1
5	Riverine	Stillwater County	NA	NA	NA	

**Table 3.3.3-9 Potential Losses from Local Plans: Flooding**

DES District	Type of Flooding	Jurisdiction	Building Loss	Societal Loss	Economic Loss	Reference
5	Riverine	Treasure County	High	Moderate	Moderate	1
5	Riverine	Yellowstone County	NA	NA	NA	
6	All Types	Daniels County	\$3,042,849	40.8	NA	2
6	All Types	Fort Peck Reservation	\$75,166,470	1,779.8	NA	2
6	All Types	Judith Basin County	\$582,000	7.3	NA	2
6	All Types	Phillips County	\$11,623,542	182.1	NA	2
6	All Types	Roosevelt County	\$78,227,304	1,990.2	NA	2
6	All Types	Sheridan County	\$7,142,582	98.6	NA	2
6	All Types	Valley County	\$88,417,740	1,319.7	NA	2
6	Dam Failure	Fergus County	NA	10	10	4
6	Riverine	Fergus County	NA	8	10	4
6	Riverine	Petroleum County	NA	NA	NA	

Notes: U = Local PDM Plan not available for review; NA = not assessed in Local PDM Plan

Potential loss was computed was not computed in a uniform manner in Local PDM Plans. See number references in *Section 7.14* for a description of the methods used to calculate potential building, societal, and economic loss.

### 3.3.3.4.3 Vulnerability of State Property

The State completed a floodplain determination on the 4,300 buildings owned or leased by the State. The results identified 29 buildings located within flood hazard zones (**Table 3.3.3-10**). The total building exposure is \$24.4 million (based on insured amount) and \$7.8 million in content. Assuming an average flood depth of 2 feet, a loss ratio of 22 percent building value and 33 percent content value (FEMA, 2002) was applied resulting in potential losses of \$7.9 million.

**Table 3.3.3-10 State Buildings within Flood Hazard Zones**

Agency	Identification	City	Building Insured Amount	Content Insured Amount
Fish, Wildlife & Parks	Big Springs Hatchery-Lewistown	Lewistown	\$385,632	\$257,136
Fish, Wildlife & Parks	Region 7 Headquarters	Miles City	\$1,045,654	\$968,272
Fish, Wildlife & Parks	Intake Structure	Miles City	\$138,216	\$62,400
Fish, Wildlife & Parks	Raceways-Big Springs Hatchery	Lewistown	\$310,789	\$0
Fish, Wildlife & Parks	Maintenance Shop (aka Old Hq)	Miles City	\$385,632	\$85,696
Justice	Gymnasium	Helena	\$503,464	\$47,133
Labor & Industry	Miles City Job Service	Miles City	\$254,623	\$119,229
Military Affairs	Chinook Armory	Chinook	\$890,562	\$278,304
Military Affairs	Chinook Organizational Maintenance Shop	Chinook	\$228,724	\$154,260
Natural Resources	Rubber Dams	Toston	\$1,560,000	\$572,000
Transportation	Miles City Equipment Storage	Miles City	\$500,000	
Transportation	Glendive Six-Stall Equipment Storage	Glendive	\$275,558	\$520
Transportation	Browning Equipment Storage	Browning	\$266,698	\$520
Transportation	Glendive Eight-Stall Equipment Storage	Glendive	\$259,584	\$520
Transportation	Miles City Office/Shop II	Miles City	\$1,446,069	\$494,894
Transportation	Miles City Old Shop	Miles City	\$342,399	\$140,400
Transportation	Glendive Office/Shop	Glendive	\$1,809,701	\$640,640
Transportation	Browning Equipment Storage	Browning	\$294,320	\$73,984

**Table 3.3.3-10 State Buildings within Flood Hazard Zones**

Agency	Identification	City	Building Insured Amount	Content Insured Amount
Transportation	Rest Area	Bridger	\$385,301	\$6,240
Transportation	Rest Area	Emigrant	\$678,287	\$20,280
Transportation	Rest Area	Dutton	\$418,372	\$8,320
Transportation	Weigh Station	Kalispell	\$20,800	\$60,320
Montana Tech of UM	College Of Technology	Butte	\$8,033,460	\$2,465,226
Justice	Cafeteria	Helena	\$942,656	\$374,920
Transportation	Rest Area	Hathaway	\$836,742	\$8,320
Corrections	Leased - Missoula	Missoula	\$0	\$285,842
Transportation	Rest Area	Gold Creek	\$418,372	\$8,320
Military Affairs	Libby Armory	Libby	\$1,732,952	\$515,320
Transportation	Rest Area	Drummond	\$41,600	\$120,640

Source: Intermountain Hazards, 2003; DOA, Risk Management and Tort Defense Division, 2007

### 3.3.3.5 Impact on Future Development

Montana law prevents development of structures in the floodway but with a permit, structures may be developed in the 100-year floodplain. Many counties have more stringent floodplain regulations than the state that are enforced. Floodplain regulations are in place to promote the public health, safety and general welfare, to minimize flood losses in areas subject to flood hazards and to promote wise use of the floodplain. The state floodplain requirement of a freeboard of two feet reduces the vulnerability of new development in the mapped flood zones. This proactive approach to floodplain management helps in making new construction less prone to flood damages. However, the program is only as good as the mapping, and in some instances, development may be occurring in unmapped, flood prone areas.

Much of the growth in Montana is occurring near rivers and streams. The Montana Floodplain Association is advocating adoption of the No Adverse Impact approach for floodplain management. No Adverse Impact standards can be incorporated into a community's zoning ordinances, subdivision regulations, building and health codes, and/or special purpose ordinances recognizing that future development can cause impacts elsewhere in the watershed.

Progress has been made on the incorporation of flood-resistant construction standards in both the International Building Code (IBC) and International Residential Code (IRC). Incorporation of standards for flood-resistant construction in these codes will help ensure that building officials become involved in that part of the floodplain management process that deals with how buildings are constructed.

Several areas experiencing growth and development in Montana are within dam inundation areas. Future development below dams can have significant financial impact on dam owners. When new development occurs in the inundation area below an existing dam that previously lacked downstream hazards, the dam could be reclassified as "high hazard". High hazard dams are required to meet stringent requirements for design, construction, inspection and maintenance. Bringing a dam up to high hazard design standards can be costly for a dam owner. Even for dams already classified as high hazard, additional downstream development can still have a financial impact. Spillway design standards are based on potential for loss of life downstream. As the population at risk increases, the spillway design standard increases. A dam that is currently in compliance with state design



standards can suddenly be out of compliance after a subdivision is built downstream. Rebuilding a spillway to provide additional capacity can also be costly for the dam owners, often exceeding a million dollars. To go along with the spillway improvements, the inundation areas have to be evaluated for risk and hazard assessment. The liability of the dam owner's increase with development which can lead to increased insurance rates.

Without consideration of dam failure during the subdivision permitting process, future development could place residences and businesses in high hazard areas. Knowledge of a home or subdivision being in a dam's inundation area may not be known by home owners.

### **3.3.3.6 Flooding Data Limitations**

#### ***Limitations to State Building Data***

To effectively determine vulnerability for State property, data identifying locations of State buildings is necessary to determine the exposure and vulnerability. The current Montana Department of Administration, Risk Management and Tort Defense Division PCIIS building database is not geo-referenced and cannot be effectively related to spatial coordinates except in general locations (by city or zip code centroid).

#### ***USACE CRREL Ice Jam Data (1998, 2004) Limitations***

A substantial amount of the USACE Cold Regions Research and Engineering Laboratory (CRREL) (1998 and 2004) information on ice jams in Montana (about 80 percent) has come from USGS Water Supply Paper 1679 published in 1966. Other publications include NWS statements, Corps of Engineers' Datacols, other USGS publications, newspapers, and personal accounts. It is important to note that the high number of recorded ice jam events on the Missouri, Yellowstone, and Milk Rivers compared to other rivers in the state reflects information gathered during field visits to that area in August 1997. There could be other rivers that experienced more ice jams than the Missouri River, but because there are few people living near the river, few if any floods or ice jams are ever reported.

The number of ice jams reported in the database for certain years largely depends on the jam location and the availability of jam records. The number of ice jam events reported in Montana increased from the 1940s to the mid-1960s, most likely because of the USGS Water Supply Paper 1679, published in 1966. Because this publication accounts for such a large portion of the Montana ice jam events in the database, it is no surprise that dates prior to its publication would have few recorded ice jam events.

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